



February 8, 2021

BY ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street, NE
Washington, DC 20554

Re: Viasat, Inc., Notice of *Ex Parte* Presentation, IBFS File No. SAT-MOD-20200417-00037 and IB Docket No. 18-313

Dear Ms. Dortch:

Last week, representatives of Viasat, Inc. held separate teleconference meetings with: (i) Greg Watson of Commissioner Carr's office (on February 4, 2021) and (ii) Erin Boone of Commissioner Simington's office (on February 5, 2021). The Viasat representatives included Angela Giancarlo and Howard Waltzman of Mayer Brown LLP (outside counsel to Viasat) and the undersigned. Both meetings focused on Viasat's positions of record in the above-referenced proceedings.

Viasat also takes this opportunity to submit for the record the attached presentation, which addresses key issues in the above-referenced proceedings, including those discussed in the meetings.

Respectfully submitted,

/s/

Amy R. Mehlman
Vice President
US Government Affairs and Policy

cc: Erin Boone
Greg Watson

Risks and Issues with Starlink Iterations

February 2021

Overview

- **SpaceX's pending third modification puts precedent-setting issues squarely before the Commission:**
 - **Orbital debris/safe flight**
 - **Equitable access to shared orbital resources**
 - **Environmental impact on the atmosphere, night sky and space**
- The Commission purposefully deferred on some of these issues in 2018, when it:
 - Agreed with NASA that satellite reliability is critical with an unprecedented 4,400 satellites
 - **Conditionally granted** SpaceX authority subject to:
 - SpaceX making a suitable future showing on orbital debris/safe flight
 - The outcome of future rulemakings, including on orbital debris/safe flight (among others)
 - Warned SpaceX that any investments based on that conditional grant would be at SpaceX's own risk pending future Commission actions

Overview (cont'd)

- SpaceX put off making the requisite further showing for two years, while it serially modified its system, and launched at its own risk
- In the meantime, the environmental impact of SpaceX's plans became apparent at the very altitude around 550 km where SpaceX seeks to deploy more satellites
- Virtually nothing in SpaceX's proposed system now resembles the one approved in 2018, including: satellite design, altitudes, orbital configuration, angles of operation, or maximum power density levels
- The proposed third modification seeks:
 - Authority to implement design modifications
 - Final authority for SpaceX to deploy ***nearly the same number of operating satellites as all of mankind has in orbit today***
- **SpaceX's approach:**
 - **Would make space less safe and less accessible for everyone else**
 - **Presents unresolved environmental issues**

Equitable and Safe Access to Space

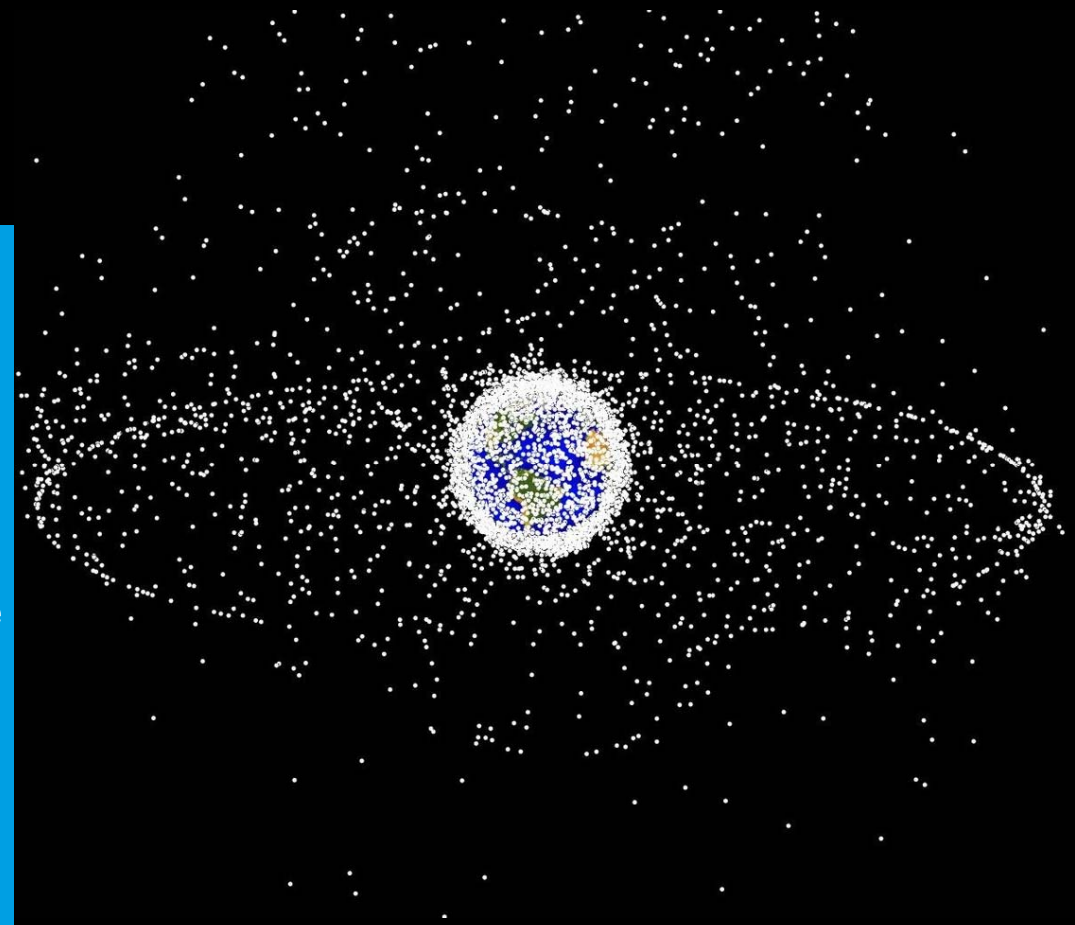
Ensuring equitable & safe access to space for everyone is a key element of the pending rulemaking on the New Space Age

“[B]ecause most useful orbital altitudes are limited but also available for use by others at an effective price that does not necessarily reflect the cost each user imposes on others, they constitute a ‘common pool resource’ such that the effective price to use space does not prevent its over-use.”

“[A]n important challenge for regulators going forward is to adopt rules and explore economic mechanisms that promote the public interest in the safe and sustainable use of space.”

“[W]e conclude that as a general matter, operators would not necessarily be incentivized on their own to take action that is beneficial for the prevention and reduction of orbital debris in orbit absent regulatory action.”

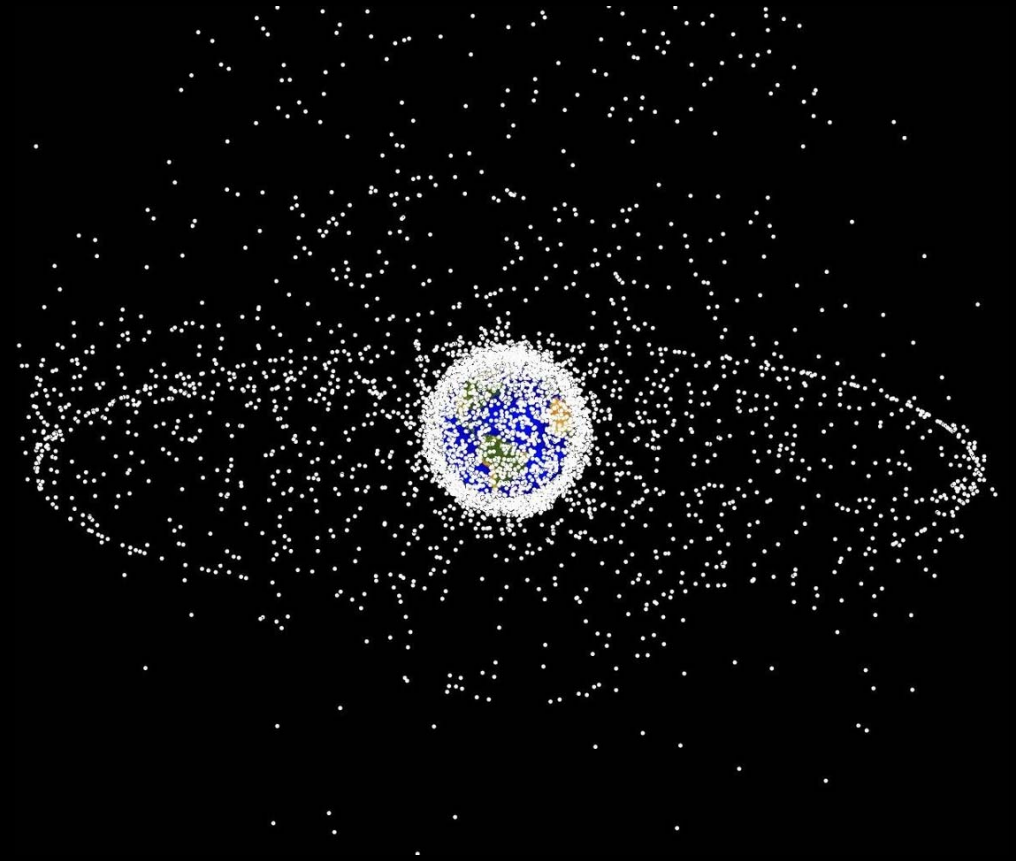
FCC 20-54, April 2020



This Application Presents Critical Policy Issues

> Ensuring shared access to limited orbital resources by many different satellite systems

- Very large LEO constellations
 - Create collision risks that imperil the orbits they share (as well as orbits above and below), particularly when deploying unreliable satellites
 - Consume limited spectrum and orbits in a manner that does not allow competitive entry
 - Increase the likelihood of a Kessler syndrome—“a space-asset destructive chain reaction” that would put a tragic end to the New Space Age for well beyond our lifetime



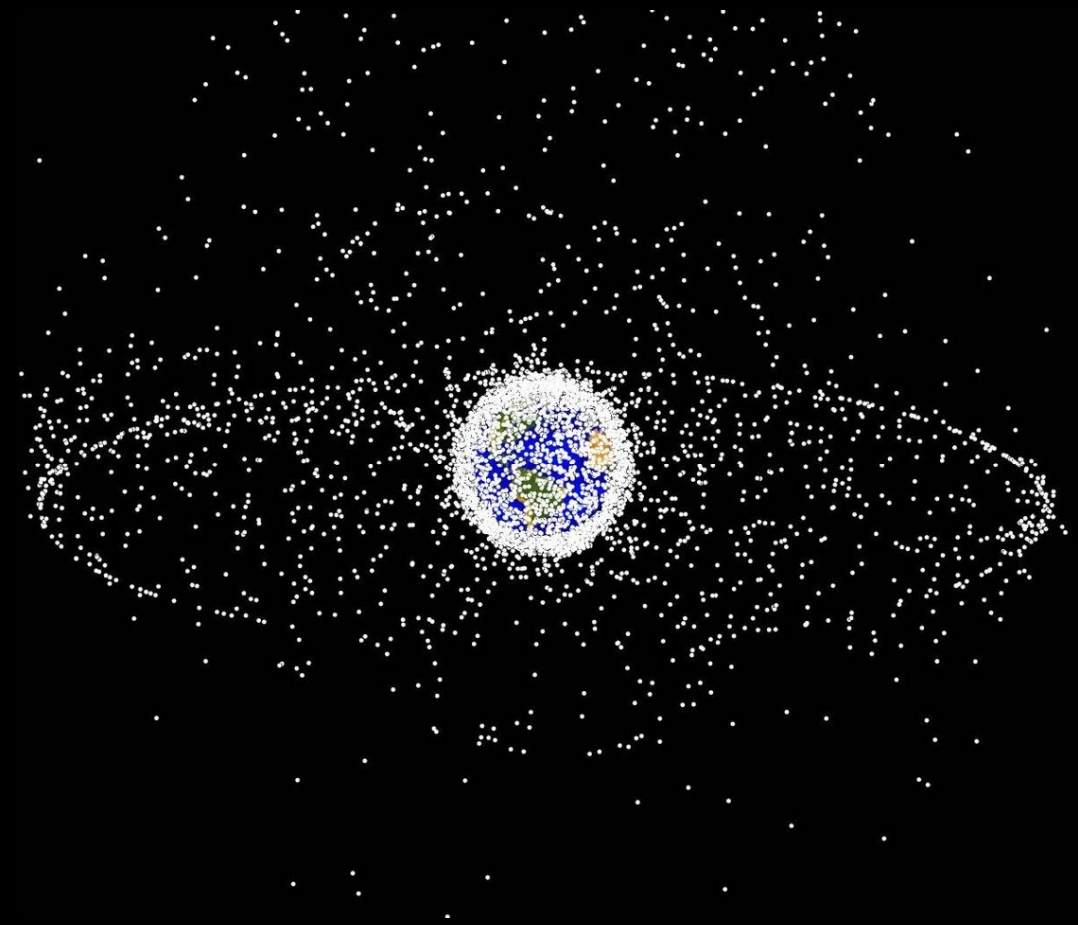
This Application Presents Critical Policy Issues (cont'd)

> **Avoiding interference to spectrum shared by other satellite systems**

- SpaceX should not be allowed to compromise the ability of others to share spectrum

> **Minimizing environmental impacts**

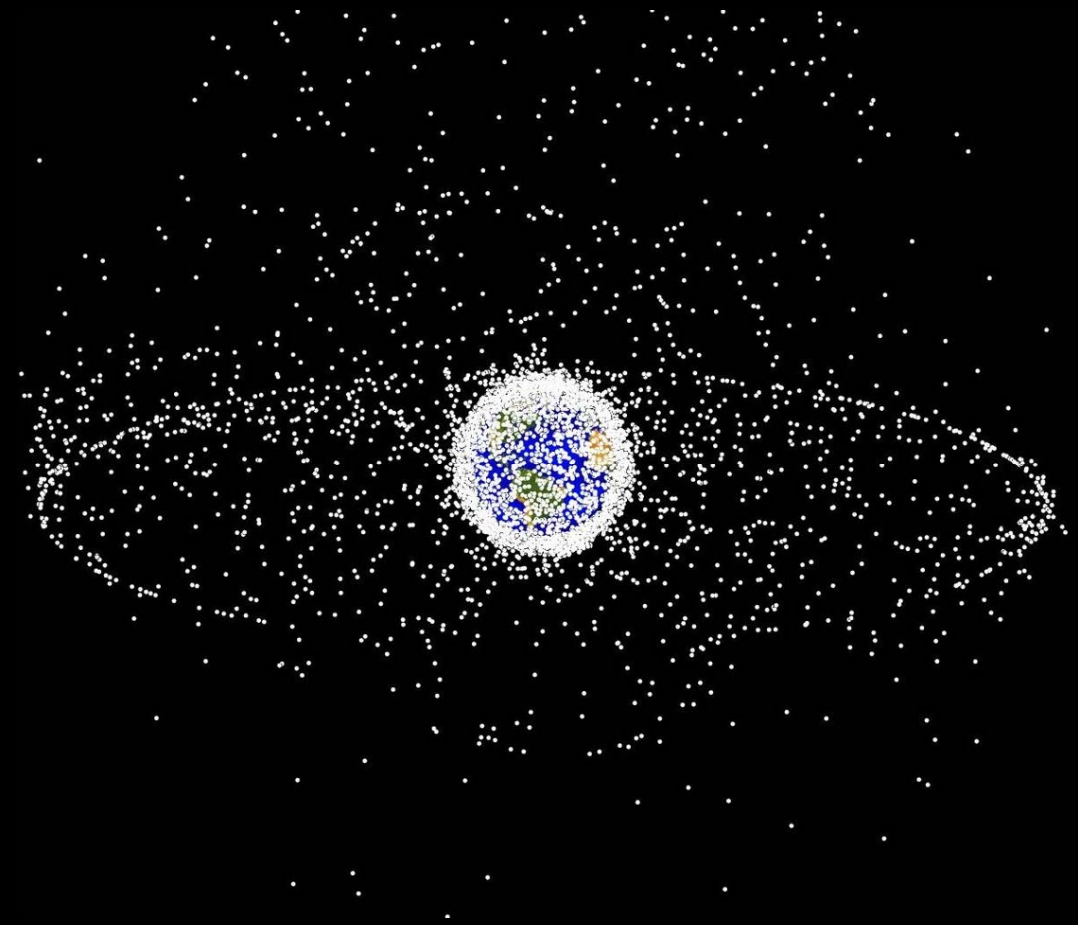
- Deploying many thousands of LEO satellites imposes needless externalities on others, including atmospheric, light and space pollution



This Application Presents Critical Policy Issues (cont'd)

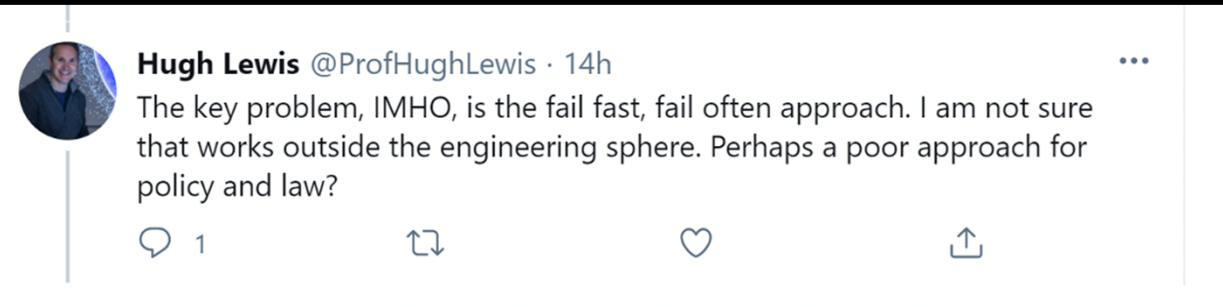
> This is the time for clear direction from the Commission

- If the Commission provides guidance about the importance of satellite reliability and space safety, the market will positively respond by fostering the mass-production of innovative, low-cost, efficient and reliable satellites and satellite components
- Space safety as a whole will be driven by the design and operation of large LEO constellations
 - All LEO orbits could be affected by irresponsible actions of one operator who has little incentive to protect the “commons”
- Industry will respond to any Commission action or inaction on these issues, including any failure to emphasize the need for safe and reliable satellites

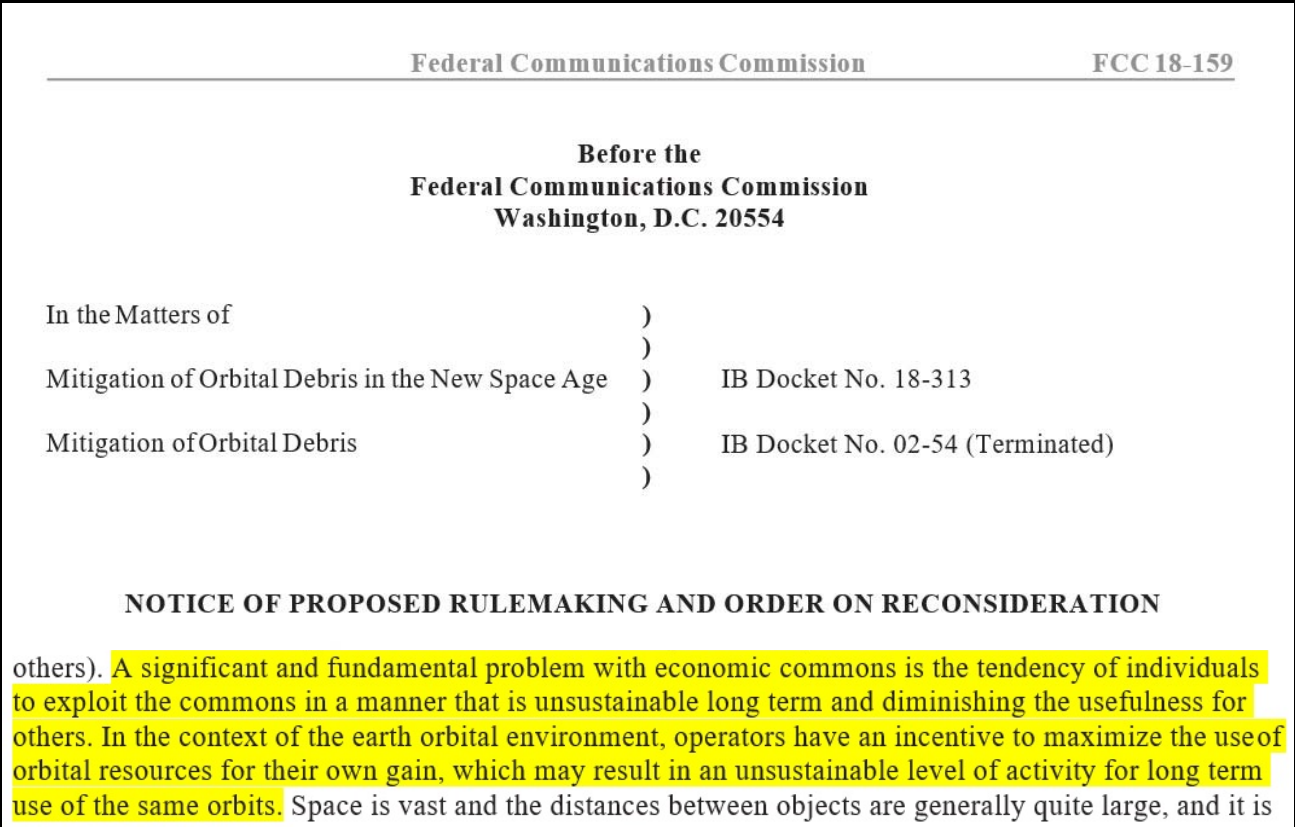


The Commission Now Faces the “Tragedy of the Commons” It Sought to Avoid in the New Space Age

- The FCC anticipated that individual operators may try to deploy systems that tolerate high failure rates **vs.** prevent high failure rates.



Dr. Hugh G. Lewis, Professor. Engineering and Physical Sciences, University of Southampton, renown UK researcher on space debris for over 20 years, leads research on space debris modelling at IADC.



Space Safety

Orbital Debris is a Growing Concern for Many Reasons



Space is becoming too crowded, Rocket Lab CEO warns

By Jackie Wattles
October 8, 2020



Could internet-providing satellites create more space junk? Some worry about space-faring future.

By Andrea Leinfelder
March 20, 2020



Elon Musk's Starlink satellites could ruin space travel forever-terrifying 'Kessler Syndrome' explained

By Charlotte Edwards
April 23, 2020



Aerospace Corp. raises questions about pollutants produced during satellite and rocket re-entry

By Debra Werner
December 11, 2020



Orbiting space debris 'the new drifting island of plastic'

By Nilima Marshall
January 12, 2021

Each SpaceX Modification Makes Space Less Safe

Greater collision risk is created by each Starlink iteration

Three separate risks under empirical measures:

NASA DAS assessment: risk of any satellite colliding with existing debris ≥ 10 cm, with individual contributions summed for the constellation

NEAT assessment : risk arising because not all conjunction warnings (possible collisions with space objects) are acted upon

- An estimated average of one warning per 26 seconds and 1.2M per year for current proposal

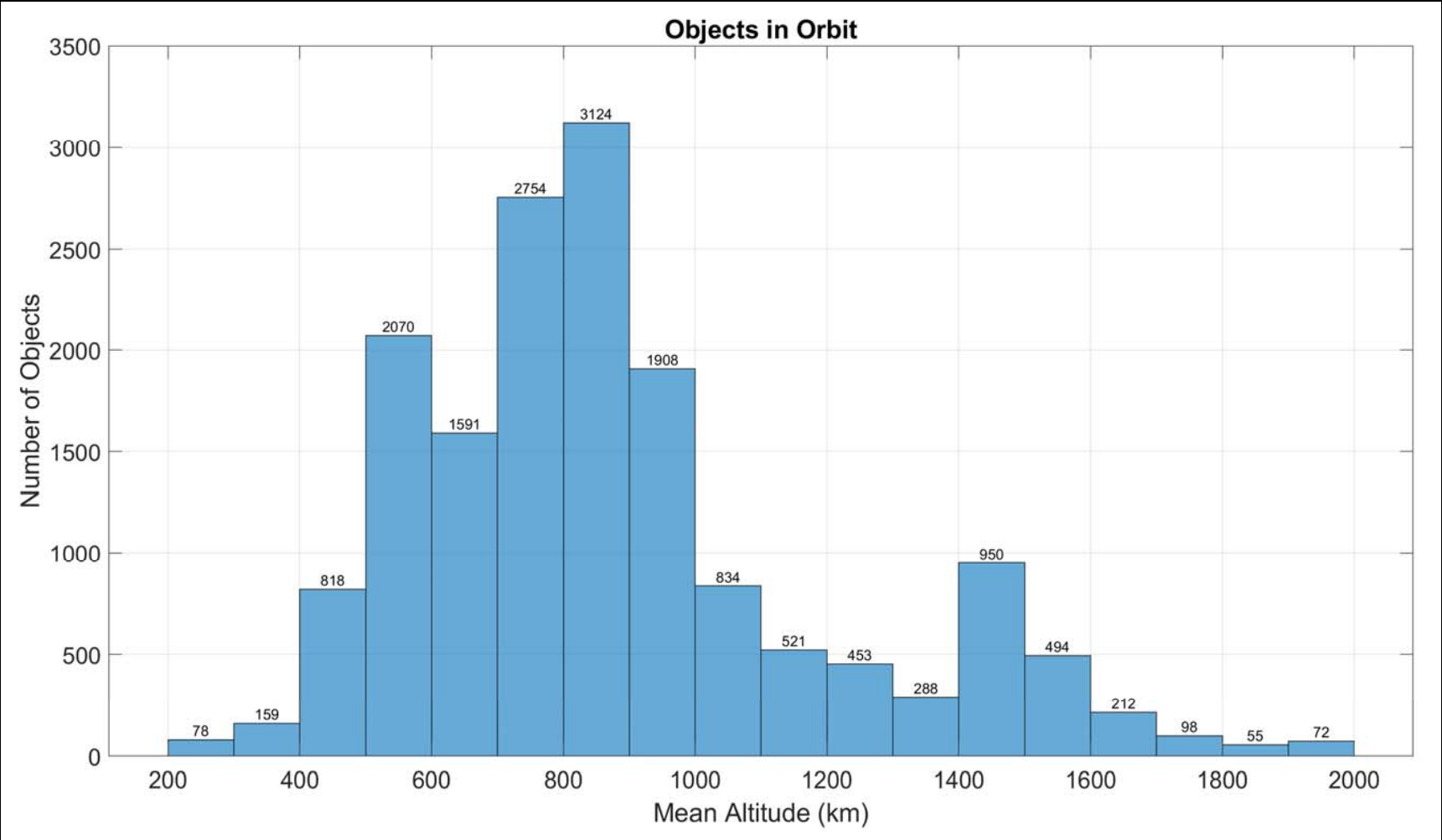
Kinetic Theory assessment: intra-system collision risk – *within* the Starlink constellation

	DAS		Kinetic Theory	NEAT
Constellation	Average Probability of Large Debris Object Collision <i>Per Satellite</i>	Expected Large Debris Object Collisions <i>for Constellation</i> Over Satellite Lifetime	Expected Intra-System Collisions <i>for Constellation</i> Per Year	Expected Collisions Not Avoided <i>for Constellation</i> Per Year
SpaceX 2016	2.22E-04	0.98	11.5	2.93
SpaceX 2018	2.67E-04	1.18	12.6	9.06
SpaceX 2020 (pending)	3.07E-04	1.35	14.5	10.88

Proposed Lower Orbits Are Less Safe

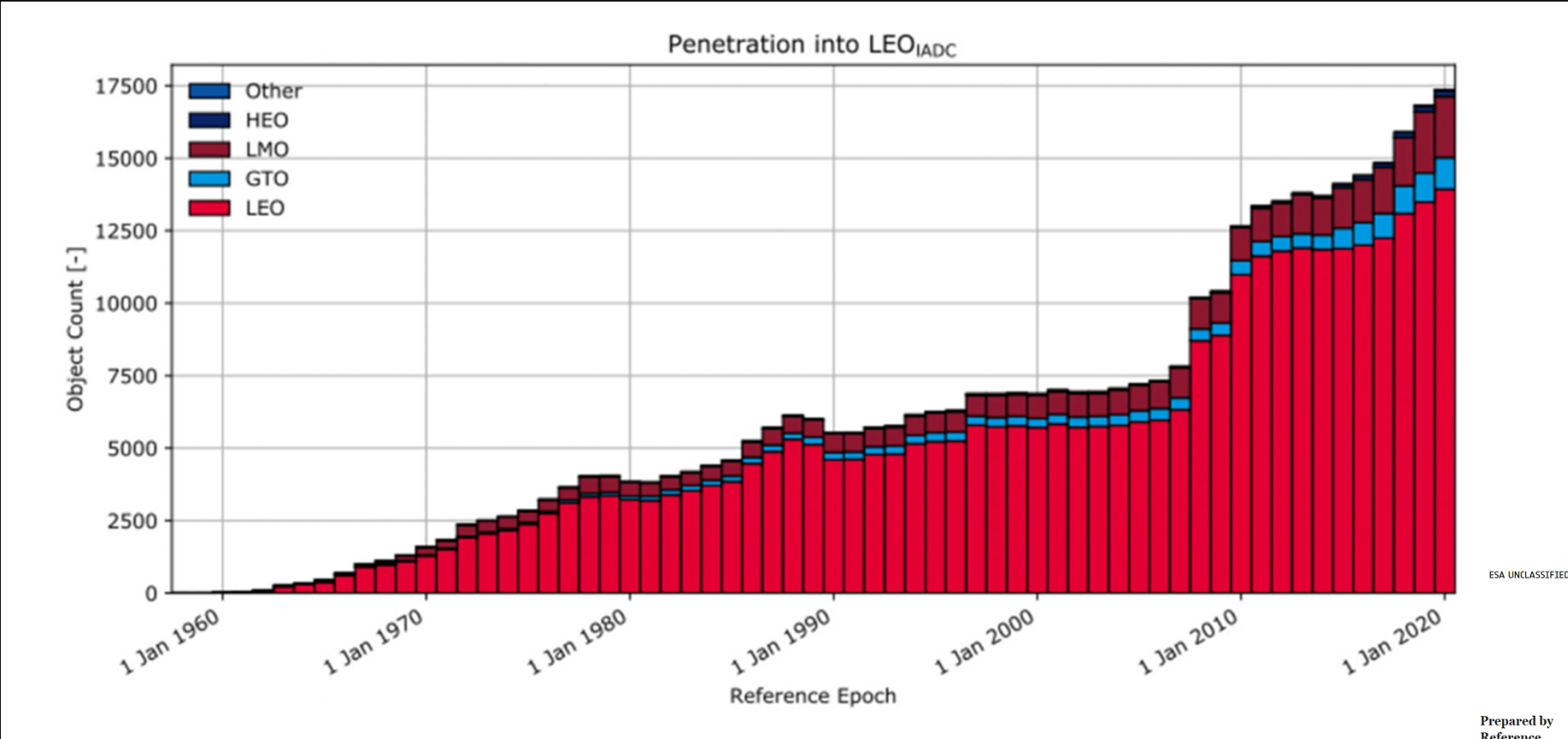
SpaceX's lower orbit range (~550 km) is more congested than previous orbits (1,100-1,325 km), and thus riskier

Existing objects in these lower orbits are less dispersed, leading to many more potential collision events, not all of which realistically can be avoided.



Growing Debris in LEO

Debris begets debris, and debris in LEO is already growing



ESA UNCLASSIFIED - Releasable to the Public

Third-Party Analysis Confirms Increasing Collision Risk

- Estimated collision rate at approx. 500 km was growing exponentially even before the latest Starlink modification
- Rate at 400-600 km increases by approx. 250x with new satellite constellations
- Excludes risk from satellites flown by the same operator (i.e., self-collisions)

2nd IAA Conference on Space Situational Awareness (ICSSA)
Washington D.C., USA

IAA-ICSSA-20-0021

LEO CONSTELLATION ENCOUNTER AND COLLISION RATE ESTIMATION:
AN UPDATE

Salvatore Alfano⁽¹⁾, Daniel L. Oltrogge⁽²⁾, and Ryan Shepperd⁽³⁾

⁽¹⁾⁽²⁾Center for Space Standards and Innovation, AGI, 7150 Campus Dr., Colorado Springs, CO 80920, salfano@agi.com, doltrogge@agi.com

⁽³⁾Iridium, 44330 Woodridge Pkwy, Leesburg, VA 20175;
Ryan.Shepperd@iridium.com

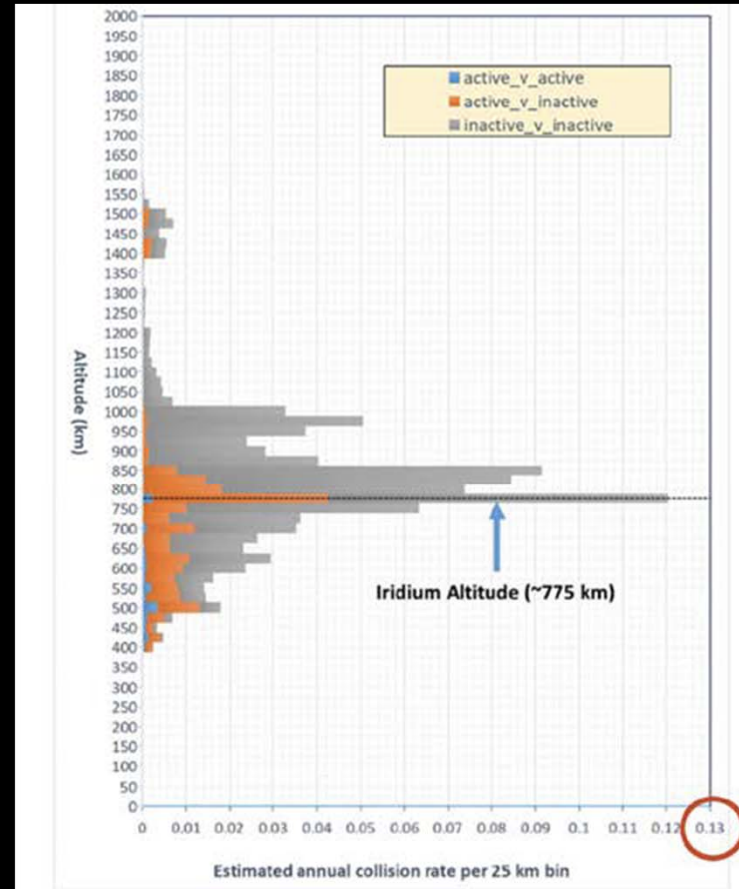
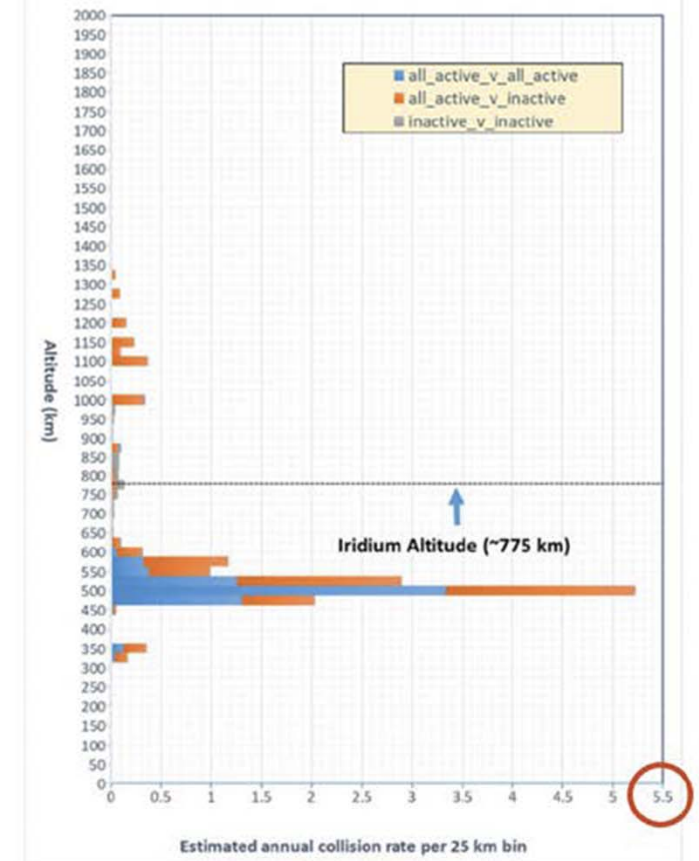


Fig. 2 Annual collision rates for October 29, 2019, 18 SPCS RSO catalogue



Annual collision rates (includes October 29, 2019 catalogue and proposed constellations)

Failed Satellites Cannot Avoid Collisions

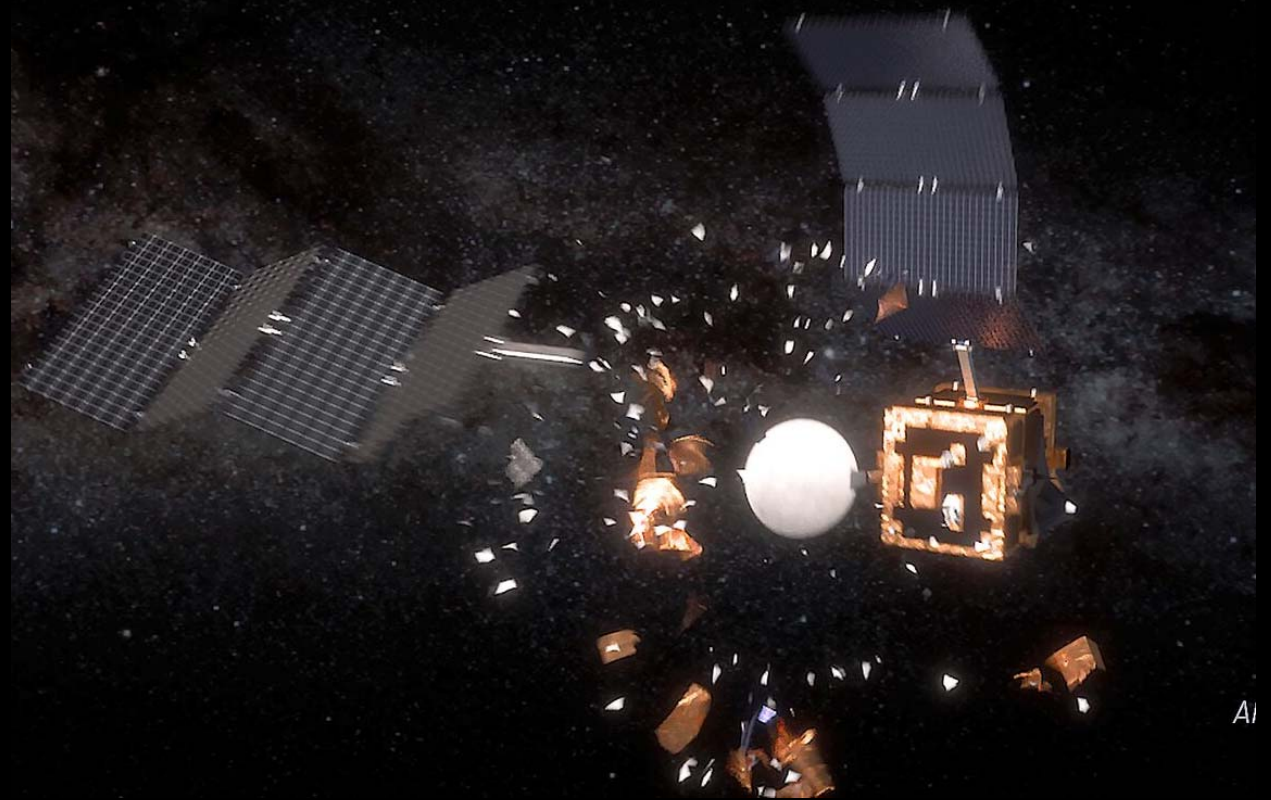
- **The ability to avoid collisions *depends on* maintaining effective and reliable maneuverability from launch through deorbit**
 - Properly working *propulsion* system
 - Properly working *command and maneuvering* systems
- **Such capability is necessary to avoid collisions with:**
 - Third party satellites
 - Non-maneuverable orbital debris
 - Satellites in the same constellation

SpaceX Failures

- **SpaceX's actual satellite failure rates to date are multiples of what it promised the Commission to get its licenses and are occurring at 550 km already!!**
 - These are infant mortality rates
 - Rates expected to grow as satellites “wear out” before they can be actively deorbited
- **An inability to operate for more than a small percentage of design life is a failure — not a success.**
 - Even in the case of satellites that have deorbited
- **Full scope and nature of these failures remains undisclosed at, and unaddressed by, the Commission**
- **The Commission simply can't turn a blind eye**
 - Experiential failures alter the collision risk analysis underlying its prior grants of authority
 - Other operators will base NGSO designs on the response (or non-response) to these critical issues

SpaceX Is Making Access to Space Riskier and More Costly for Everyone Else

- Failed Starlink satellites can't avoid collisions if they can't reliably and effectively maneuver as long as they remain in orbit
 - At the altitudes proposed in the pending modification, they can remain unguided missiles for up to 6 years
 - **Collisions with softball-sized space objects are like a bomb going off**



Decay Times for Debris from Collisions at 550 km

- > **Collisions of failed Starlink satellites at 550 km risk polluting orbits many 100s of km above and below with large fields of fast-moving shrapnel**
- > That debris would:
 - Traverse those other orbits for decades or a century
 - Impair use of those orbits and harm many other users

Apogee (km)	Decay Time
550	13.7 years
650	17.8 years
750	28.6 years
850	42.9 years
950	59.9 years
1050	79.7 years
1150	96.5 years
1250	> 100 years
1350	> 100 years

Decay time calculated assuming 550-km perigee, typical debris 0.01 m²/kg area-to-mass ratio, and 2020 start of decay

Promises Unkept

Instead of deploying the safe and reliable system it promised, SpaceX admits it has deployed one based on disposability and replaceability (i.e., redundancy in large numbers of satellites)

SpaceX's failure rate is at least

2.8x

the 1% level they said they would
be “nowhere near”

SpaceX's failure rate is even higher (8.3%)
if you include the first 60 satellites – the
very same satellites SpaceX otherwise relies
upon in its public interest advocacy

- > FCC inquiry: “Please provide an analysis of collision risk, assuming rates of satellite failure resulting in the inability to perform collision avoidance procedures of 10, 5 and 1 percent.” *March 21, 2017*
- > SpaceX response: “SpaceX will construct its spacecraft to specifications and tolerances designed to ensure that failure rates are nowhere near the levels postulated in this question.” *April 20, 2017*

More Promises Unkept

- Instead of pausing deployment when it experienced unforeseen levels of failure, SpaceX has accelerated satellite deployment while awaiting Commission action
 - SpaceX response to FCC inquiry: “Thus, even in the unlikely event that an unforeseen circumstance arises, SpaceX would be able to defer further deployment until the problem has been identified and corrected before resuming launch of subsequent spacecraft.” *April 20, 2017*
- Instead of using injection orbits where failed satellites deorbit in a matter of weeks, SpaceX is now launching into injection orbits above 500 km where it takes years for failed satellites to deorbit
 - SpaceX response to FCC inquiry: “SpaceX also uses a very low injection altitude of its satellites, which means satellites that lose maneuverability [sic] at deployment will demise in less than a month.” *May 15, 2020*

SpaceX Resists Independent, *Scientific*-Based Analysis of its Proposal

- > Collision risk assessments
 - On an aggregate basis for its entire constellation
 - Accounting for known and expected changes in the orbital environment
- > Why its satellites have failed and what impact those failures have on:
 - Reliable and effective collision avoidance
 - Collision risk assessments
- > The interference impact on NGSOs, GSOs and terrestrial networks
- > Whether SpaceX's satellites fully “burn up” when they reenter the atmosphere
- > The environmental impact, including climate change, light pollution, and pollution of space

FACT SHEET: President Biden Takes Executive Actions to Tackle the Climate Crisis at Home and Abroad, Create Jobs, and Restore Scientific Integrity Across Federal Government

JANUARY 27, 2021 • STATEMENTS AND RELEASES

*Biden-Harris Administration Commits on Climate Change –
Creating Jobs, Building Infrastructure, and Delivering
Environmental Justice*

Today, President Biden will take executive action to tackle the climate crisis at home and abroad while creating good-paying union jobs and equitable clean energy future, building modern and sustainable infrastructure, restoring scientific integrity and evidence-based policymaking across the federal government, and re-establishing the President's Council of Advisors on Science and Technology.

Critical Questions Remain Unanswered

> SpaceX refuses to disclose:

- The root causes of its failures
- How it has permanently corrected the causes of its failures
- How it can achieve a suitable failure level over the 5-year design life of its satellites

> Only SpaceX can explain what has really happened to its system since SpaceX urged the Commission almost four years ago to:

- Hold all applicants to the same “high standard” of low failure rates
- Ensure all applicants have “adequately considered and planned for mitigation of orbital debris that would pose a serious danger to all other users of space”

Critical Space Safety Questions Warrant Investigation

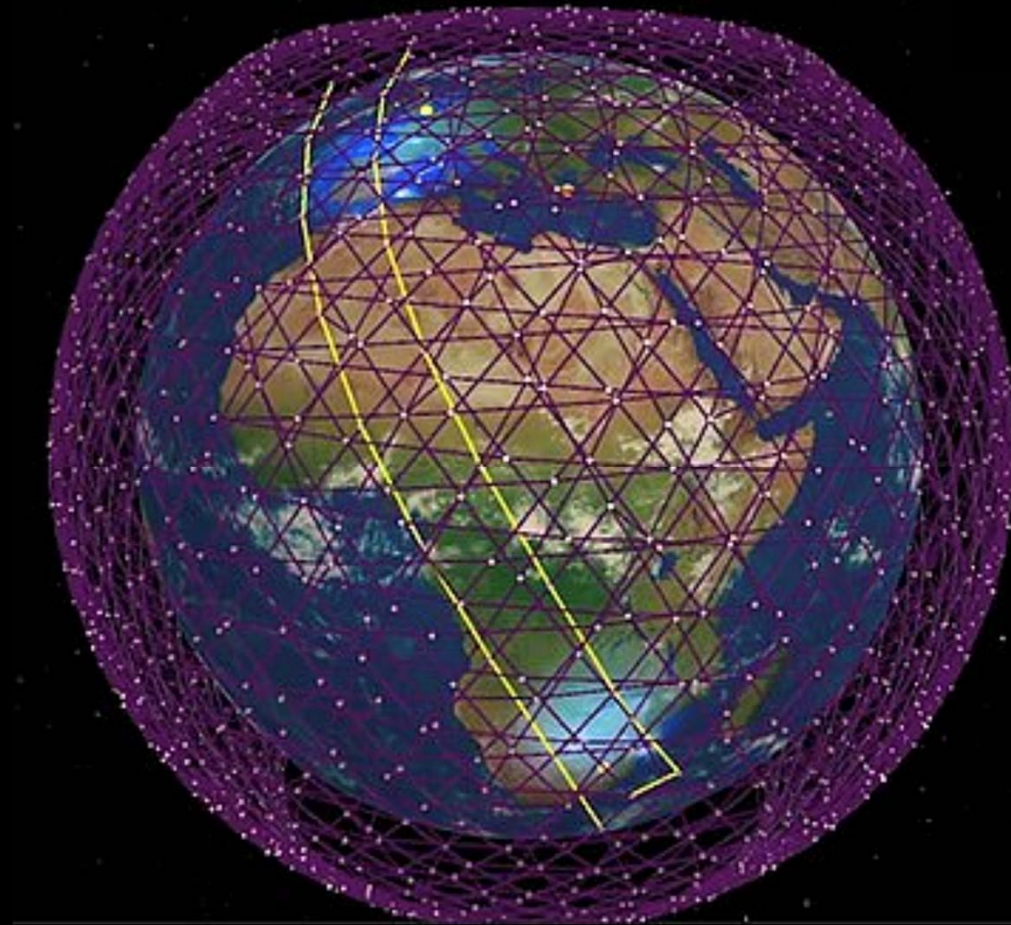
The Commission determined in April 2020 that it would revisit grants of authority if failure rates exceed expected reliability levels:

“We may also revisit the basis for an applicant’s license grant should it become evident that the licensee’s satellite performance with respect to orbital debris mitigation is not consistent with what was specified in the application. In appropriate circumstances, the Commission could subsequently modify the license in accordance with Section 316 of the Communications Act to address risks that depart materially from the expected level of risk or reliability, since that departure would affect the public interest assessment underlying grant of the license.”

FCC 20-54, April 2020

SpaceX Obfuscates the Total Risk

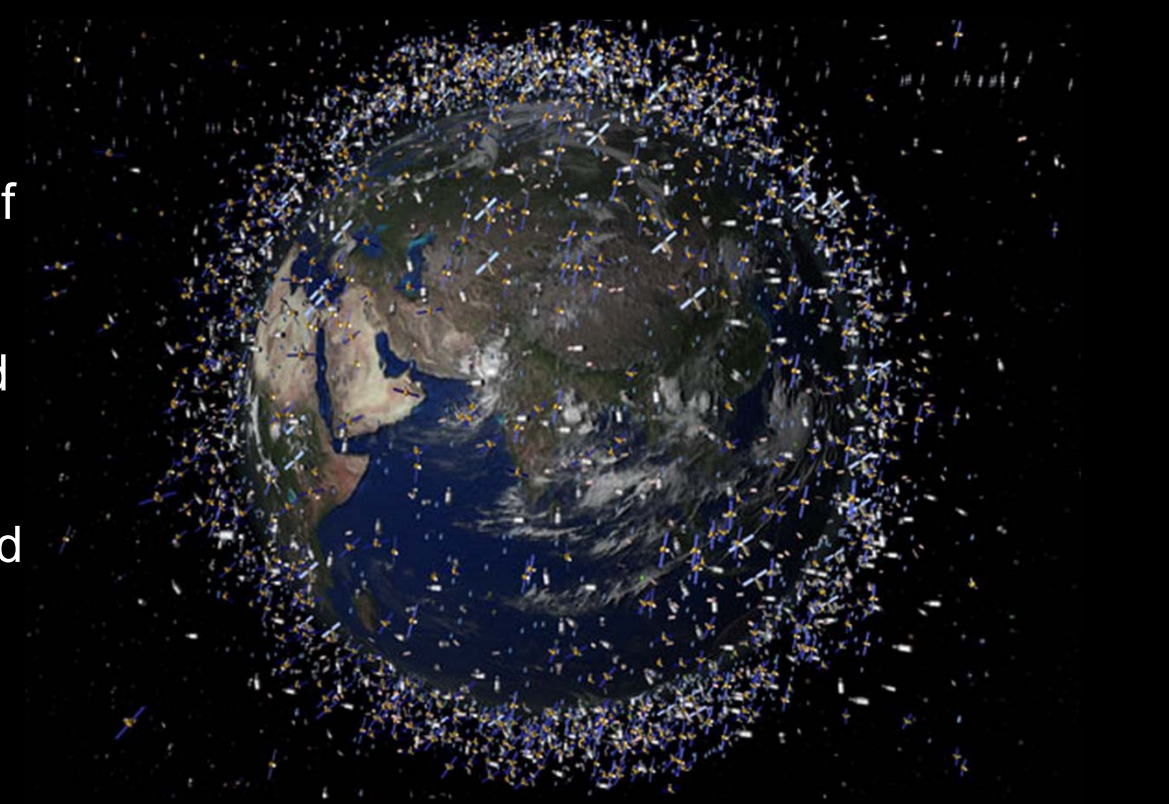
- SpaceX has resisted Commission efforts to measure aggregate collision risk across its multi-thousand-satellite system
- **SpaceX refuses to acknowledge what the vast majority of the industry acknowledges:**
 - Collision risk increases with numbers of satellites in a constellation
 - Aggregate collision risk limits are needed



SpaceX's "Safety vs. Spectrum Choice" Paradigm is Based on False Premises

- SpaceX's proposed design is the least safe-space proposal it has made
- SpaceX has not kept its commitments about the reliability of its spacecraft
- SpaceX has not paused launches in the face of unexpected failure, as it committed to do
- There is no connection between the safety issues presented by Starlink and Amazon's quest for spectrum access

The "false and dangerous choice" would be deciding to ignore these issues and still act on the pending modification application



Other Orbital Issues

Sharing Limited Orbits

- SpaceX's proposal to operate across a wide range of orbits would constrain shared access to the same orbits
 - SpaceX's application seeks wide latitude to operate from ~510 km to ~600 km
 - Taking into account its proposed +/-30 km tolerance for apogee and perigee
 - The Commission recently imposed an upper limit of 580 km on all Starlink satellites
- SpaceX must be able to operate its satellites with close tolerances to avoid large numbers of potential collisions with orbital debris
- SpaceX touts 1 km separation as adequate from other NGSOs
- SpaceX should maintain an orbital tolerance of +/- 5 km or better to maintain room for others in the shared highway that is space

"The more SpaceX's satellites are in that altitude range, the less room there is for other companies to later put stuff there," McDowell said. "The grabbing-up of all the good territory is a reasonable complaint."

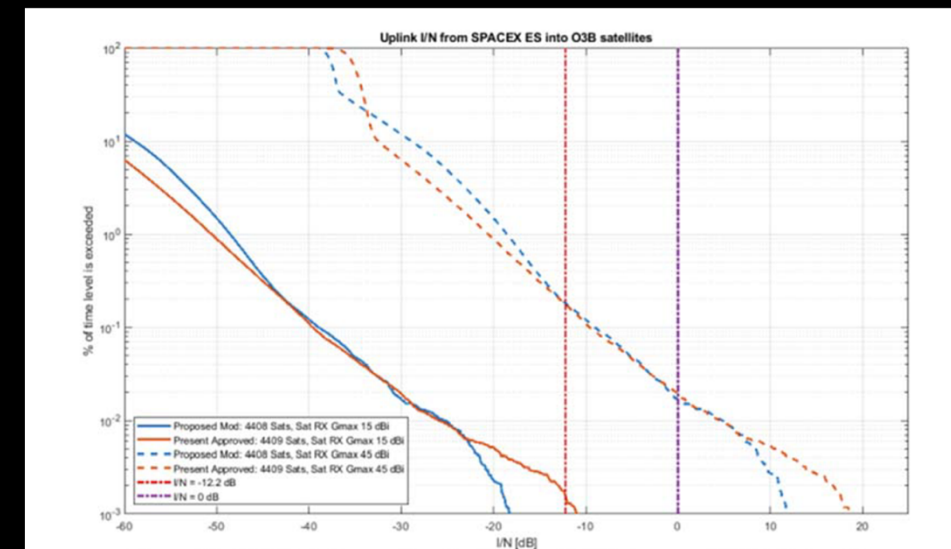
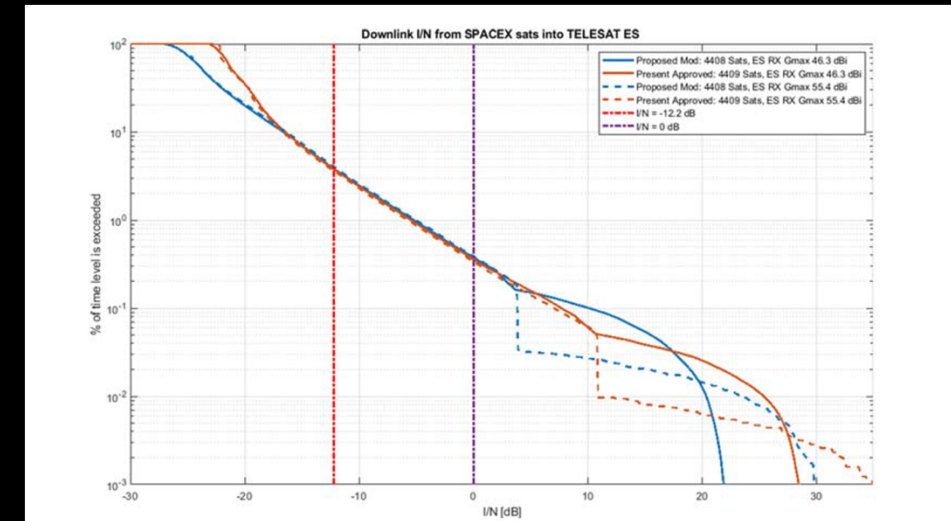
The Verge, quoting Professor Jonathan McDowell

20-Jan-2021

Interference

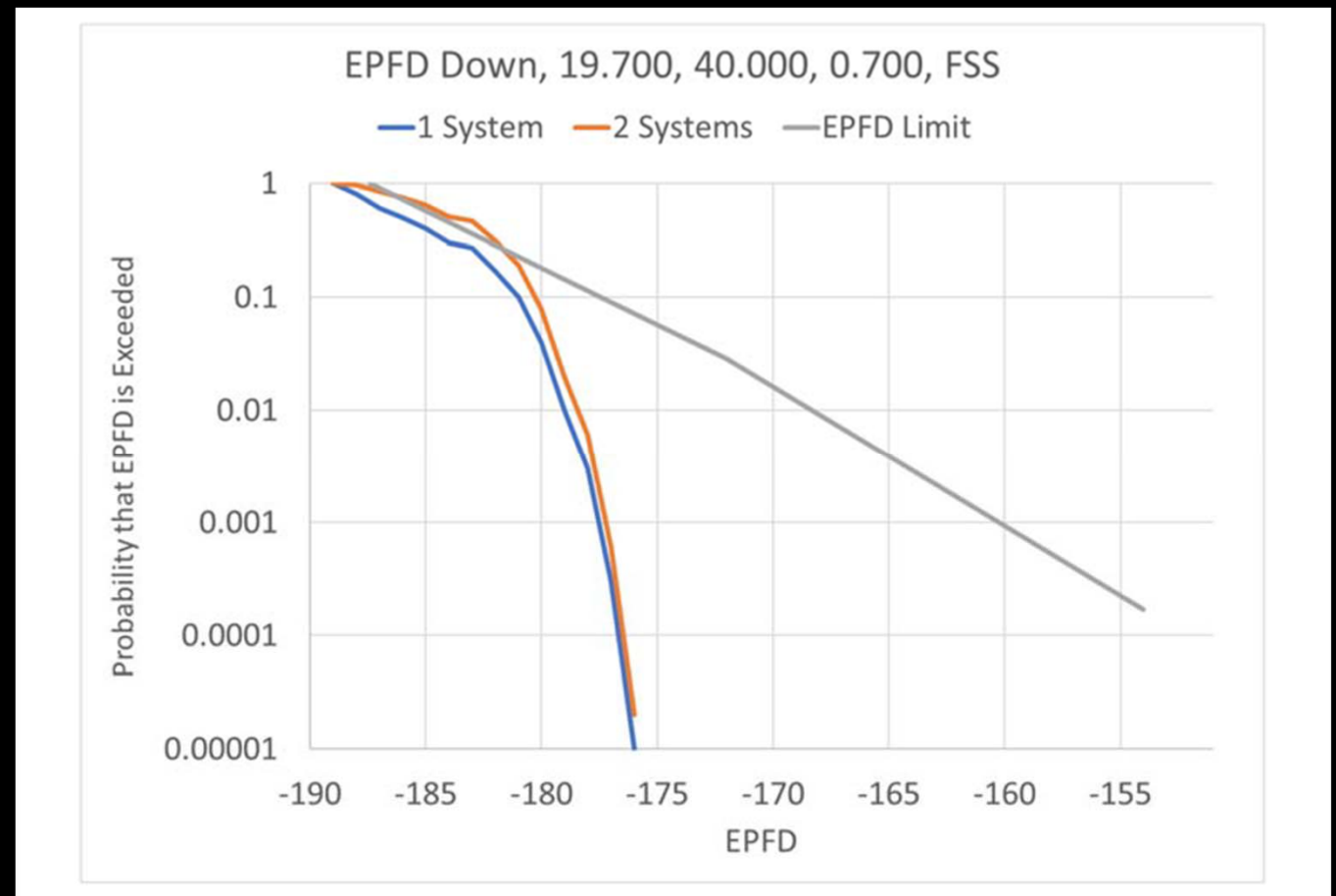
Increase in NGSO Interference

- SpaceX's own analysis (not Viasat's) shows SpaceX's modification will cause **increased interference to other NGSO systems**
 - This conclusion is SpaceX's itself, using the "I/N" interference metrics it proposes
- When faced with this issue, SpaceX remarkably asserts that its interest in avoiding self-interference somehow will prevent this harm to others from arising
- There is no basis on which to conclude SpaceX's self-interest would protect its competitors from interference
 - This is particularly true when SpaceX is otherwise planning to occupy virtually all available look angles to NGSO orbits, impairing others' ability to share spectrum



Impermissible GSO Interference

- **SpaceX does not deny that it is impermissibly “double dipping”** by relying on two ITU filings — both a Norwegian and a US ITU filing — to increase the level of interference it otherwise can cause to GSO networks
- The Commission told Amazon it must show compatibility using just one such “single entry” ITU limit on which the Commission’s GSO protection criteria are based





Environmental Concerns

Third-Parties Support Examination of Environmental Issues

- > Aerospace Corporation and Scientific American indicate **study is needed on the impact of atmospheric reentry**
- > Various parties confirm **dark and quiet sky issues remain unsolved at ~550 km**
 - Recent research indicates that
 - SpaceX has not achieved the reduction in light pollution it sought to achieve
 - More work is needed to address serious optical and radio astronomy concerns
- > OECD has issued a call to action on the **growing orbital debris crisis in LEO**

- > The American Astronomical Society (AAS) commented:
 - *“We support consideration by the Commission of light pollution and impacts to optical astronomy”*
 - *“[W]e appreciate Viasat’s support in this regard”*
 - *“[W]e appreciate Viasat’s drawing attention to the light pollution and problems posed to the astronomical sciences by satellite constellations”*

Third-Parties Support Examination of Environmental Issues

SPACENEWS[®]

Aerospace Corp. raises questions about pollutants produced during satellite and rocket reentry

by Debra Werner — December 11, 2020

“[E]nvironmental impacts of rocket emissions, space debris and re-entry plumes warrant attention given the significant increase in space activity in recent years.”

“[S]pace enterprise has seen little environmental oversight, and continuing space operations without reliably quantifying and mitigating for its environmental impacts has costs.”

“More analysis is warranted to appropriately quantify and account for environmental impacts along the entire space supply chain to ensure both terrestrial and space sustainability.”

William Ailor, Technical Fellow, the Aerospace Corp.’s Center for Orbital and Reentry Debris Studies

Third-Parties Support Examination of Environmental Issues: Atmosphere



Environmental Impacts of Satellites from Launch to Deorbit and the Green New Deal for the Space Enterprise

Lee Organski, Cayman Barber, Shawn Barkfelt, Madison Hobbs, Roy Nakagawa, Dr. Martin Ross, Dr. William Ailor

“There is substantial research and analysis focused on what may remain upon reentry and survive to reach the surface, but there is ostensibly no research into what happens to the remainder.”

“It is concluded that the marked increase in these pollutants calls for the close tracking of mass flux, further research on the particulate distribution and radiative forcing, general research into reentry physics, and a study of possible solutions to mitigate the issue.”

Third-Parties Support Examination of Environmental Issues: Atmosphere

“[P]articles from reentering space junk will be a zoo of complex chemical types.

Particles from vaporizing propellant tanks, computers, solar panel and other exotic materials will form around an 85-kilometer altitude, then drift downward, accumulating in the stratosphere along with the launch’s soot and alumina.

Reentry is as much of an “emission” as a launch.”

“The growing low-Earth orbit mega constellations, with thousands of satellites in each constellation, use reentry vaporization as the satellite end-of-life disposal mechanism.

Once these constellations are deployed, hundreds of tons of nonfunctioning satellites will be “brought in” for disposal every year. Most of this mass will become particles in the middle atmosphere. **Very little is known about reentry dust production, the microphysics of the particles, and how reentry dust could affect climate and ozone.”**

“It will be easier to guarantee unimpeded use of space systems if the environmental impacts of every stage in a system’s life cycle are evaluated ahead of time. This is how aviation contemplates sustainability. Environmental concerns that appear after deployment encourage regulation. Full and complete analysis before deployment inoculates against regulation.”

SCIENTIFIC
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FEATURES

An Underappreciated Danger of the New Space Age: Global Air Pollution

Martin N. Ross and Leonard David

Third-Parties Emphasize the Importance of Environmental Issues: **Astronomy**

“This situation has taken a perverse turn as indifferent radio spectrum regulators authorize the launch of mega-constellations in non-geostationary orbit that degrade the appearance of the night sky and hinder optical astronomy with unforeseen optical reflections.”

“No currently apparent combination of known mitigations can completely avoid the impacts of tens of thousands of LEOsats on the science programs of the coming generation of astronomy facilities.”

“If satellite operators can achieve their goals with fewer satellites, this is the simplest mitigation.”

“The night sky is a precious resource shared by all the humanity. It is our duty to protect and preserve it so that scientists can continue to carry out groundbreaking research and so that society at large can continue to learn more about the Universe we are surrounded by.”

On-line Workshop

**Dark and Quiet Skies
for Science and Society**

Report and recommendations



UNITED NATIONS
Office for Outer Space Affairs



Pedro Duque

Minister for Science, Innovation and
Universities, Spain

ESA Astronaut

Third-Parties Support Examination of Environmental Issues: Debris

“Economic and societal vulnerabilities to space hazards, in particular space debris, are growing.”

“Space debris protection and mitigation measures are already costly to satellite operators, but **the main risks and costs lie in the future, if the generation of debris spins out of control and renders certain orbits unusable for human activities.**”

“[T]he real game changer would be the full deployment of one or several of the broadband mega-constellations that are under preparation.”

“With the deployment of one or several of the announced broadband mega constellations, **the number of operational satellites in orbit could double or even triple in the next five years.**”

“With this level of orbital density, according to multiple modelling efforts, **it is not a question of if a defunct satellite will collide with debris, but when.**”

“The increasing use of the low-earth orbit raises a number of additional issues ranging from space debris, radio interference to light pollution for astronomic observations.”

Federal Law Mandates a Full Examination of the Environmental Issues

- NEPA requires that SpaceX's request for final authority to deploy 2,284 spacecraft be evaluated as it "may have a significant environmental impact."
- **These environmental impacts may include:**
 - Depleting ozone, contributing to climate change, causing unpredictable changes in atmospheric chemistry, and creating dangerous falling debris from satellites that do not fully burn up on reentry
 - Creating excessive light pollution that interferes with the ability of astrophotographers, astronomers, and ordinary stargazers to study and enjoy space, and tarnishes the beauty of the night sky
 - Increasing the risk of collisions in orbit and generating excessive space debris that pollutes the orbital environment

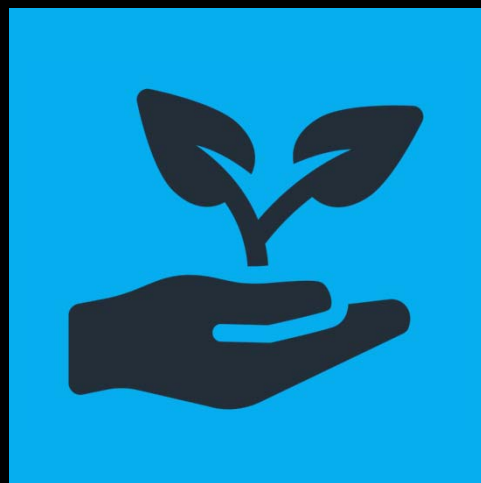


This is Not a Choice Between Safe and Clean Space or Better Broadband

Deploying Fewer, More Capable NGSO Satellites:



Reduces Collision Risk



**Reduces
Environmental Harm**



**Facilitates Shared and
Equitable Access to
Limited Spectrum and
Orbit Resources**



Facilitates Competition

Conclusion

> **The Commission cannot address the SpaceX modification application without:**

- Requiring SpaceX to address the unresolved issues about the reliability of its satellites and the aggregate collision risk of Starlink
- Confirming whether and how SpaceX will protect NGSO, GSO and terrestrial users from increased interference
- Requiring that SpaceX operate at closer orbital tolerances to share limited orbits
- Preparing an Environmental Impact Statement (or at least an EA) that evaluates all potentially significant impacts and relevant alternatives—including denial and a reduction in the total number of satellites

> **The Commission must act on its Orbital Debris Mitigation FNPRM and adopt:**

- An aggregate collision probability metric for large NGSO systems
- Measures to ensure that NGSO systems are built, deployed, and operated in a manner consistent with the bases for grants of authority, including commitments made in the applications